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LESSONS LEARNED FROM CONTRACT DEFINITION,

(FORMERLY PROJECT DEFINITION PHASE)

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PREPARED FOR

OFFICE OF THE SECRETARY OF DEFENSE

DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING

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PREFACE

This pamphlet presents the most significant lessons learned from projects which have undergone Concept Formulation and Contract Definition (CD). In presenting these lessons, it is hoped that on future projects, both government and industry will be able to benefit from these past experiences.

The information presented in this pamphlet was collected from government and industry sources who were or are now involved with fulfilling the requirements stated in DoD Directive 3200.9. The following projects were studied:

- Titan III Standardized Space Booster
- LANCE Field Ballistic Missile
- Mobile Mid-Range Ballistic Missile (MMRBM)
- Medium-Altitude Communications Satellite (MACS)
- Integrated Helicopter Avionics System (IHAS)
- Integrated Light Attack Avionics System (ILAAS)
- Advanced Aerial Fire Support System (AAFSS)
- Heavy Logistics Transport (C-5A)
- Advanced Surface Missile System (ASMS)
- Mark 48 Torpedo
- Manned Orbiting Laboratory (MOL)

A summary of the most significant lessons learned from the experience with Contract Definition is presented first, followed by a more detailed discussion.

We wish to express our appreciation to the contributors for their time and interest.

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BACKGROUND

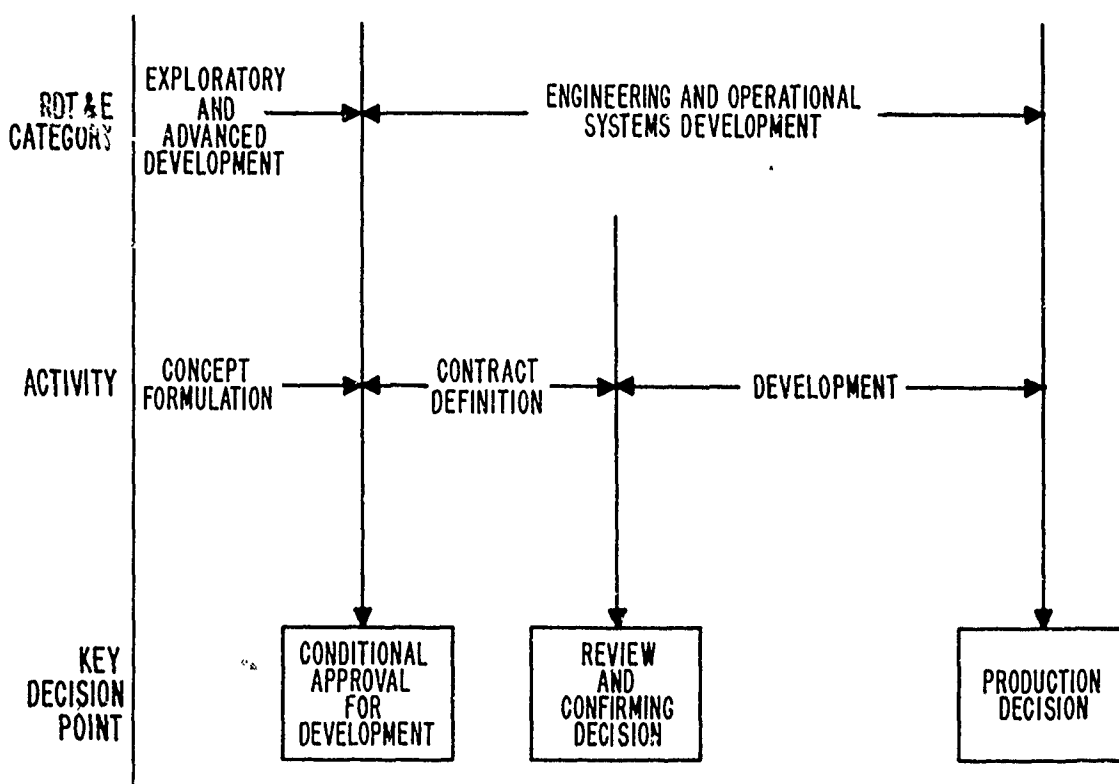
Contract Definition (CD), formerly called the Project Definition Phase (PDP), was established because the government had experienced serious problems with a number of major development projects. These problems have plagued development projects since World War II. Some systems did not live up to their advertised operational effectiveness; large cost over-runs occurred on other projects; many projects, after substantial investments of time and money, had to be cancelled because of the extent of the troubles they were experiencing; disruptive changes, caused by over-dependency on technological breakthroughs, beset still other projects. Other projects that did not experience serious problems were cancelled or drastically reduced in scope because of the financial demands of higher priority projects which were encountering some of the above difficulties.

DoD personnel felt that a competitive, two-phase approach to development, supported by tools such as incentive contracting, value engineering, configuration management, and PERT COST, might help solve some of these problems. This two-phase approach was first applied, on an experimental basis, to the Titan III Standardized Space Booster, the Army LANCE Missile, the Mobile Mid-Range Ballistic Missile (MMRBM), the Army and Air Force portions of the Communications Satellite Program, and the Navy Mark 48 Torpedo (formerly called the EX-10 Torpedo).

This experience resulted in DoD Directive 3200.9, dated 24 February 1964. The Directive was revised on 1 July 1965 to incorporate some of the lessons learned from the early CD experience. At this time, a change was made in terminology from "Project Definition Phase" to "Contract Definition."

The Directive underscores the importance of obtaining, as the output of Contract Definition, achievable performance specifications, backed by a firm fixed price or fully structured incentive contract. The Directive also stresses heavily the importance of pre-Contract Definition analyses, decisions, and plans. The period during which these analyses are made, called Concept Formulation, provides the foundation upon which CD and the ultimate development effort rest.

The chart below shows the relationships of CD to the RDT&E Budgetary Categories. Key decision points and the activities that precede these points are indicated.



SUMMARY OF LESSONS LEARNED

The following paragraphs summarize briefly the more significant lessons learned from Contract Definition experience. In the next section of the pamphlet, each lesson is discussed in depth, supported by specific examples.

A. The success of Contract Definition depends on the quality of analyses, decisions, and plans made during the Concept Formulation period. Perhaps the most important lesson learned is that the quality of the work and planning accomplished by the government during Concept Formulation will determine whether subsequent phases proceed in an orderly fashion or prove difficult.

B. Lack of adequate government guidance in the RFQ and Contract Definition Work Statement will be reflected in the contractors' Contract Definition outputs. When the RFQ's do not contain adequate information on technical and operational objectives and do not prescribe a structure for the information to be supplied, the contractors' proposals tend to be either underresponsive or overresponsive and thus difficult to evaluate.

C. The government must provide adequate direction to the contractors during Contract Definition. Close collaboration between the government and the contractors during CD is necessary to strengthen the final output.

D. The management capability demonstrated by the contractors during Contract Definition is a significant determinant in selecting the winner of the development contract. One of the most important advantages of CD to the government has been the opportunity to observe and evaluate the contractor project teams in operation prior to awarding the development contract.

E. The government should define and communicate the parameters within which intra-system trade-offs are to be made, but should allow the contractors freedom in making trade-off decisions. The contractors can often achieve significant technical, cost, or schedule improvements when given enough information and latitude to make appropriate component trade-offs.

F. Both the government and the contractors have encountered severe problems in developing and using the specifications prepared during Contract Definition. Some projects were delayed during CD because interfaces were inadequately defined or because specifications submitted by the contractors were too vague to be used as bases for fixed price or incentive contracts.

G. The quality of project planning during Contract Definition establishes, to a large extent, the level of visibility that the government will have during development. The change from cost plus fixed fee to fixed price and incentive contracting has resulted in a different buyer/seller relationship. The government now must depend to a great extent on formal reporting for program visibility. The quality and usefulness of status reporting depend on establishing a meaningful information structure and base during CD.

H. Contract Definition has created a new prime contractor/subcontractor relationship. The prime contractor/subcontractor relationship has been affected by the problem of funding subcontractors during CD, the problem of responsiveness of subcontractors to overall program objectives, and the problem of security of competitive information.

I. The potential benefits of technical transfusion depend on the government's ability to gain unlimited rights-in-data for designs proposed during CD. Contractors and subcontractors are reluctant to release designs proposed during CD, because they fear it will weaken their competitive position.

J. A major difficulty with Contract Definition has been the excessive delays in initiating development. Some of the early CD projects experienced excessive delays in selecting the winner and negotiating the development contracts. These delays caused a series of crises within the government, resulted in schedule slippages, and created serious funding problems for the industrial competitors.

K. The contractors' marketing costs have increased substantially as a result of Contract Definition. Contract Definition usually requires that a contractor win two competitions before being awarded a development contract. Industry's response to this requirement has been to increase its marketing and research expenditures in order to achieve the level of customer confidence required to win.

LESSONS LEARNED FROM CONTRACT DEFINITION EXPERIENCE

A. The Success of Contract Definition Depends on the Quality of the Analyses, Decisions, and Plans Made During the Concept Formulation Period.

The most important lesson learned from Contract Definition experience is that a strong Concept Formulation effort must be carried out by the government. Of the five projects that underwent Contract Definition prior to issuing the initial DoD Directive 3200.9 (dated 24 February 1964), only two were ready to enter Contract Definition as it is known today. Of the remaining three projects, analyses, decisions, and plans were made during CD that properly should have been completed prior to CD. As a result, the Contract Definition for these three projects extended beyond what is considered a reasonable period of time. Specifically:

- one of the three projects eventually was cancelled during CD;
- the second, a large missile booster project, underwent substantial re-direction when it was learned that an assumption on technical approach was not valid; and
- the third, a communications project, was reoriented when its mission was redefined.

When the DoD Directive was issued in February of 1964, it prescribed a set of prerequisites that were to be satisfied before the project would be approved for initiation of Contract Definition. Fulfilling the prerequisites became a major concern of government project teams seeking approval of their projects for CD. On a missile project, the government funded several contractors to undertake studies specifically to fulfill CD prerequisites. These studies were not conclusive. Consequently, the government formed a large committee (comprised of representatives of DoD, industrial contractors, nonprofit institutions, and consultants) to substantiate that the prerequisites had, in fact, been met and, in particular, to verify that the system was more cost effective than competing DoD systems.

In another more recent project, the Army formed a special technical evaluation team and gave it a charter to select the best technical approach from among many alternatives proposed. As a result of its analysis, the evaluation group presented the Army with a recommendation which ultimately was the basis for the Contract Definition that was approved and conducted.

On a current aircraft project, however, the mission of the weapon system overlapped with the mission of a competing system that a different service sponsored. During the Concept Formulation period, the problem of mission overlap was temporarily resolved by a narrower mission definition for the new program, and the system was given OSD approval to proceed with Contract Definition. While this system has a stated mission and a favorable cost effectiveness relative to other DoD systems, the problem of mission overlap was not finally resolved. Both the project office and contractor personnel are still concerned about the project's future. Thus, this issue of mission overlap, which should have been settled in the Concept Formulation period by OSD and the Departments involved, must still be faced.

Subsequent experiences demonstrated the need for even more emphasis on Concept Formulation. These experiences proved that basic mission, technical, operational, and cost issues and problems must be faced and resolved during Concept Formulation, so that development and production can proceed in an orderly fashion. The DoD Directive was revised in July 1965 to place even more emphasis on the accomplishment of the prerequisites.

B. Lack of Adequate Government Guidance in the RFQ and Contract Definition Work Statement Will Be Reflected in the Contractors' Contract Definition Outputs.

One contractor interviewed stated that, "The government's Contract Definition Work Statement didn't clearly define what was wanted, and the government project manager was reluctant to discuss the requirements during Contract Definition." Since the purpose of CD is to assure that the proposed system will achieve a balance among operational effectiveness, schedule, and total life cycle cost, the government must clearly state its goals in the RFQ and the CD Work Statement. The government further must specify the form, general content, and depth of information that it expects from contractors during CD.

It is also important that the Work Statement's structure and emphasis on individual tasks be related to the government's source selection and evaluation criteria. The objectives of the program, the guidance in the RFQ and Work Statement that directs the contractor toward these objectives, and the criteria that will be used to judge his work must be closely correlated.

O. several of the early Contract Definitions, the evaluation criteria were not prepared until CD was underway. As a result, the RFQ and Work Statement were not well related to the source selection criteria. Contractors on some of these early projects indicated that they were not attentive enough during CD to

certain areas that later turned out to be significant in the evaluation of the proposals; or else, they emphasized other areas which turned out to be of less importance than they had anticipated. One member of a contractor's management staff stated, "When the government doesn't say what is important and what is not, then we rely on marketing strategy principles to determine what must be emphasized." He felt that had the government given them an indication of how they would be evaluated, much misdirected effort would have been applied to the more important tasks.

The RFQ and Work Statement for a Navy project with a large production follow-on potential did not specifically direct the contractor to explore means during Contract Definition for achieving a lower production unit cost that would result in lower life cycle cost. Consequently, the contractors did not place a high enough priority on a lower cost design.

On another project, the responsible DoD agency heavily emphasized the importance of lower life cycle cost in the early system definition document, the operational requirement, and the Technical Development Plan (TDP). Both the RFQ and the Work Statement called the contractor's attention to the importance of a low life cycle cost. Later, the government based its contractor selection, to a significant extent, on the competing contractors' plans to meet this cost objective.

Contractors on an Army project experienced difficulties in the identification and selection of contract end items. One contractor's interpretation of the requirements of the RFQ resulted in his identifying approximately 75 end items, while the other contractor selected 500 end items. The performance specifications, PERT COST Work Breakdown Structure, test plans, and other planning documents for these end items were therefore substantially different in the proposals submitted by each contractor. Not only was it difficult to compare the two contractors in source selection, but it was extremely difficult to write the contract for the development phase, because one contractor's planning was too detailed, while the other's was incomplete.

In more recent RFQ's and Work Statements, contractors are being directed to perform specific trade-off analyses. In most cases, these analyses focus on critical areas of the system that are likely to improve operational effectiveness, technical performance, or life cycle costs.

When guidance is too vague and general, the contractors often have overresponded in order to include everything that they feel that government might want. As a result, the proposals have become excessively long and difficult to evaluate. Also, some contractors in their zeal to win the development contract have initiated detailed work that properly should take place during development.

It should be emphasized that the purpose of the RFQ and Work Statement is to communicate fully to prospective contractors the results of Concept Formulation, the operational and performance requirements of the system, and the latitude open to the contractors in their CD efforts. The RFQ must include the necessary guidance, study reports, and data which are the foundation of the system definition to that point in time and which will provide the necessary information base from which responsive proposals can be prepared.

C. The Government Must Provide Adequate Direction to the Contractors During Contract Definition.

During some of the earlier projects, the government project team limited its CD participation to simply responding to contractor questions. In some cases, the answers to questions asked by one contractor were given to all competitors. Both contractors and government project officers agreed, in retrospect, that this type of an "arms-length" relationship severely limited the quality of the CD effort.

An interviewed Army project manager commented that when any member of his office made comments, suggestions, or requests for analysis, the response from the contractors was always very comprehensive. He compared direction of this type to "power steering," where a little government initiative produced extensive results from the contractors. He felt that this interchange between the government and the competing contractors improved the results of Contract Definition substantially. He also felt the government project team members had to be careful to steer the contractors in a truly productive direction, rather than in "nice to know" but nonessential areas of inquiry.

Members of a contractor team that underwent Contract Definition and who are now in development recalled from their experiences that they carried out extensive investigations in areas where the government project team indicated interest. As a result of these investigations, in some cases, they decided that a different approach was warranted; in other cases, they provided comprehensive evidence that the original choice was better. In all cases, contractors felt that these investigations during CD benefited the project.

Military project office and contractor personnel from all eleven of the surveyed projects stressed the need for the government to assume a stronger role during CD. On the other hand, the problem of retaining fair competitive conditions poses a dilemma for government managers. As one contractor stated, "We are continually worried that the government may inadvertently give our competitor one of our important concepts. . . How can we avoid this and still get the

help we need?" The answer of one government manager was, "We provide negative guidance only – that is, we tell our CD contractor when he's getting off the track or going further in an area than is necessary." This concept of "negative guidance" is now generally accepted in DoD as an appropriate approach.

In summary, it has been shown through early CD experience that the key to a successful Contract Definition is a spirit of close collaboration between the government and the CD contractors. The government should provide direction by informing the competing contractors when their approach is technically incorrect or unsound, when their approach is not clear to the government, or when the approach needs amplification. This kind of negative guidance achieves the benefits of close collaboration, while maintaining an environment of fairness to all competitors.

The government project team, however, is in a position to lead a contractor to victory or defeat, so extreme care must be taken to ensure fairness. The government team should not suggest specific technical approaches, since by so doing, the creativity of the contractors will be restricted and the potential benefits of Contract Definition reduced. With the proper balance, collaboration between the government and the contractors will result in a better overall program plan and in the best possible contract document for development.

D. The Management Capability Demonstrated by the Contractors During Contract Definition Is a Significant Determinant in Selecting the Winner of the Development Contract.

Contract Definition affords the government the opportunity to observe a contractor's management policy and his approach to the project under study. The contractor's management capability (i.e., responsiveness to the requirements of the program, make-or-buy policy, capability to manage subcontractors, strength, authority, and responsibility of the contractor project team, and ability to execute the development program) are some of the most important factors in contractor selection for development. The government's first-hand evaluations of these factors during CD is a significant determinant in selecting the winner of the development contract.

One electronics firm that experienced CD described it as "an evaluation period during which the government can answer the following questions:

"How rapidly does the contractor respond in staffing and organizing for Contract Definition?

"Does contractor top management provide the resources and proper support for the Contract Definition effort?

"Does the program manager have the responsibility and authority to get work done in-house?

"Is there stability and purposefulness in the contractor's organization during Contract Definition, or are there many changes and extensive shuffling of personnel, indicating disorganization or lack of support by management?

"How well does the contractor manage the funded subcontractor's effort to provide direct support during Contract Definition?

"How well does he select and motivate the potential subcontractors?

"Is the contractor able to achieve the environment of realism and objectivity both in his own organization and in the potential subcontractors' organizations?

"Is the contractor able to establish a fixed price environment both in-house and with the subcontractors?

"How aggressive is the contractor in seeking out assistance from the military department agencies?

"How responsive is the contractor to program direction, and does he meet deadlines?"

An Army project manager commented that on his project the winner exhibited, through his management plans and decisions, real responsiveness to the needs of the project. Because of the strong project organization, a make-or-buy policy that took advantage of industry's technical resources and production potential, and manifestations of corporate interest in the project, his approach impressed the government team. The loser, on the other hand, presented a weak project organization, a make-or-buy policy that was obviously intended to set him up in new businesses, and an indifference toward the project by top management.

E. The Government Should Define and Communicate the Parameters within Which Intra-System Trade-Offs Are to Be Made, but Should Allow Contractors Freedom to Make Trade-Off Decisions.

Some projects in Contract Definition have suffered because pertinent information needed for trade-off analyses was not available. On many past projects, inadequate cost-of-ownership data hampered the contractor from making the most meaningful cost effectiveness analyses and trade-off decisions. A Navy project officer on a current CD effort commented that many decisions that affect life cycle costs are being made based on weak cost-of-ownership assumptions. This situation is particularly serious, since ownership costs frequently contribute to between 25 and 35 percent of total life cycle costs. A major cause of the problem of collecting ownership cost data is the poor accounting procedures. This general inadequacy of cost-of-ownership data prompted a contractor who worked on one of the earlier CD projects to recommend that DoD undertake a comprehensive study of these costs and establish a data bank for such information.

In addition to some inadequacies in cost-of-ownership data available to CD contractors, some contractors noted deficiencies in basic system information. For example, the contractors on one project did not receive a defined mission envelope from the government until CD was almost completed. On a second project, the contractors did not receive information defining the interface with a mating system that was under parallel development until nearly the end of CD. In both these situations, the contractors proceeded on their own assumptions. As a result, not only were the cost effectiveness and trade-off analyses of questionable validity, but also the task of evaluating the competing contractors was made more difficult.

The government has benefited greatly on those projects on which the contractors were given latitude to make competent trade-offs. These benefits included lower life cycle cost, better technical approaches, and improved technical knowledge in key risk areas. On a Navy program, the contractor chose to trade-off higher development costs for lower production unit costs. His decision to spend approximately \$10 million more in development made the design simpler and less expensive to produce, potentially lowering production costs for a specified number of units by \$50 to \$60 million. For example, the contractor's decision to use molecular electronic circuitry, wherever possible, produced weight and space savings (and since then, industry-wide reduction trends in molecular electronic pricing have resulted in circuitry costs that are as much as 300 percent lower than originally estimated).

In another example of the cost savings that resulted from trade-off analyses, a missile contractor proposed the use of a recoverable instrumentation package in qualification system testing instead of the expendable package recommended by his competitor. The recoverable package was between 30 to 50 percent more

costly to produce than the expendable package; however, even considering the cost of recovery and repair, the use of the recoverable package resulted in a substantially lower total cost.

Contract Definition began on one early Air Force program with the assumption that an already developed propulsion subsystem would be integrated intact into the system. However, an extensive analysis of the subsystem demonstrated that the earlier decision would be reversed. Consequently, a new subsystem, which was specified during CD, was able to meet the performance objectives. Development cost estimates for this system were increased over 50 percent, but performance, cost, and schedule objectives were more realistic as a result of CD. If the project had been conducted without Contract Definition, the unsuitability of the propulsion subsystem would undoubtedly have been discovered at a later date during the development, but at that time, the discovery would have precipitated a major crisis, probably with extensive cost and schedule consequences.

On an early CD project, the government specified the propulsion system that was to be used. One of the contractors who was unsuccessful in getting into CD believed that his proposing an alternate propulsion system disqualified him. Likewise, one of the CD competitors confided that he would have preferred to have proposed an alternate system, but his marketing judgment suggested that he comply with the government's approach. It is entirely possible that an alternate propulsion system would have made a significant contribution to the system, but this potential is lost when the government rigidly specifies the components to be used.

In two more recent projects, the contractors were given specific direction regarding the trade-off studies to be performed. In one instance, the CD competitors were to present detailed trade-off analyses to support their selection of an engine which was to be government-furnished equipment and was to be developed in parallel. In this case, the system contractor, who would be held responsible for total system performance, was permitted to make the trade-off decision on this GFE engine.

Trade-off studies have also been made in critical project problem areas. On one aircraft project, all contractors forecast a weight problem for the system being defined. The traditional weight/payload/range trade-offs came under extensive, continuing analysis throughout Contract Definition. Several alternative approaches were examined in detail by the project office and industrial contractors. The final decision, which was made prior to writing the development contract, provided the best compromise among the operational objective, technical

feasibility, and cost. Thus, the problem was faced and a solution reached in CD which eliminated the disruptive changes and redirection in development that plague many projects. One Navy project that went through Contract Definition has experienced 90 percent fewer changes during development than a similar Navy development project that was initiated before Contract Definition became a requirement.

The philosophy of trade-off analysis was given a rather interesting extension by the successful missile contractor on an early CD project. After development began, the prime contractor was working closely with a major subcontractor to assist him in making a trade-off decision. The subcontractor, who was faced with a trade-off decision of performance for both development and production costs, also had to select the second-tier subcontractor for the work. The prime and subcontractor agreed to hold a small-scale, funded CD-type competition for this particular hardware component. Using the same basic CD concepts and guidelines that the prime and subcontractor had worked under, two second-tier competitors produced final reports much like the CD final reports submitted by the prime to the government. As a result, the selected contractor had the best overall solution, a technical approach that was considered sound, and higher development costs than his competition, but a total life cycle cost that was substantially lower. In addition, the winner's approach allowed the prime contractor to maintain his project schedule, which at that time was in danger of slipping.

In summary, CD contractors should have the freedom to optimize their systems for operational effectiveness, life cycle cost, and project schedules within the overall mission and performance envelopes. It is during Contract Definition that important design alternatives are examined and decisions are made that establish the level of operational effectiveness, the cost of acquisition, and the cost of ownership for the system or equipment.

F. Both the Government and the Contractors Have Encountered Several Problems in Developing and Using the Specifications Prepared During Contract Definition.

Developing specifications during Contract Definition has been a source of difficulty for both the government and the contractors. For example, on certain projects, the following problems occurred:

- Significant delays in writing a definitive contract were experienced because the specifications were vague.
- Inadequate information from the government created difficulties in specifying interfaces with mating systems.

- Over-specification of the system requirements by the government severely restricted the contractors' design latitude during Contract Definition.

In the early CD projects, one of the most commonly experienced difficulties was in developing specifications that would provide realistic bases for fixed price or incentive contracts. In three cases, the contractors submitted hardware specifications that include many best-effort performance targets or goals. So that effective contracts could be written, the contractors had to rewrite and resubmit the specifications, based on minimum acceptable performance values rather than targets. For example, the specifications were revised to say "achieve a minimum acceptable range of 600 miles" instead of "achieve a target range of 800 miles." Preparation and evaluation of the new specifications contributed directly to delays of as much as 10 to 14 weeks in initiating the development effort.

Contractors on a more recent CD stated that the government-furnished system requirements did not contain enough interface information to complete their specifications. Since their systems had to be compatible with a mating system, these contractors had to obtain additional interface information directly from the contractor who had designed the mating system.

Other contractors commented that government over-specification of system requirements limited many of their design choices. They felt that hardware details that were specified properly belonged in development. Had this time and talent that were devoted to detail design been applied to examining performance trade-offs, the projects would have benefited more.

Several contractors noted that they had engaged in detail design work during CD. They said that they had made their trade-off studies earlier and had decided to go into detail design to keep their project team busy during CD. These contractors elected to do work before Contract Definition that could have been done during Contract Definition with government funding.

G. The Quality of Project Planning During Contract Definition Establishes, to a Large Extent, the Level of Visibility That the Government Will Have During Development.

The "arms-length" government/industry relationship during development, which results from the use of fixed price and incentive contracting, gives renewed emphasis to the importance of the formalized project planning carried out during Contract Definition. The effectiveness of the formal status reporting by which the government retains visibility depends on the structure and substance of the information system established during the CD-planning effort.

This point is illustrated by contrasting two recent projects. One Navy project employed a contractually specified planning and reporting system, the details of which were determined during CD. During the development effort, the contractor submitted formal status information on the progress of technical performance, cost, and schedule for the project. Further, the contractor regularly reported his projections of procurement costs. On this project, the government project manager had, from the beginning, the kind of status reports he needed to manage the effort.

On the second, an Army project, no such formal arrangements on the details of the planning and reporting system were made before development began. As the project progressed in development, the Army project manager found it increasingly difficult to obtain the status and forecast information he needed. In one particular instance, a technical failure occurred in a subcontracted portion of the system. Since there was no final requirement to apprise the prime contractor, or in turn, the Army project office, the problem did not become known to the Army until it was too late to easily correct the situation. A significant schedule slippage and an attendant cost overrun resulted. After this incident, the Army and the contractor finally agreed to define and implement a formal planning and control system that was tailored to the project needs and that would provide adequate visibility. Unless adequate formal reporting is required during development, the benefits of CD planning will be lost.

In essence, unless the content and extent of planning and reporting is contractually agreed- to before development begins, the government is likely not to get the information it needs, and the contractor is likely to be plagued with sporadic and unrealistic requests for information.

H. Contract Definition Has Created a New Prime Contractor/Subcontractor Relationship.

There are three types of Contract Definition relationships between prime contractors and subcontractors: a prime contractor working with a single subcontractor, a prime contractor working with many subcontractors who are bidding on one or more subsystems, or a subcontractor working with more than one prime contractor. Three areas of concern to all contractors, prime or subcontractor, that exist under one or more of these CD working relationships are:

- the funding of subcontractors;
- the responsiveness of subcontractors to overall program objectives; and
- the security of competitive information.

Contract Definitions for two projects with large follow-on production potential were conducted by teams composed of a prime contractor and a single subcontractor. In both cases the major subcontractor, who was bidding for about 30 to 40 percent of the development contract dollars, was funded for this proportion of the prime's CD contract dollars. In both projects, the subcontractor made substantial contributions to the prime's success. In discussing the problem of funding CD subcontractors, the prime contractors agreed that providing adequate funding made the subcontractors more responsive to the primes' requirements and that without adequate funding, the subcontractors would probably not have made the effort needed to win.

On projects where many subcontractors are bidding on more than one subsystem, consensus among prime contractors is that adequate funding for all subcontractors is not possible because of the fund limitation on the primes' fixed price CD contract. From the primes' point of view, however, they saw subsidiary benefits in not funding the subcontractors under these conditions. First, time delays can be avoided on a short CD effort by the subcontractors being able to act rapidly without concern for contractual coverage. This rapid response is important since the prime contractor is required to go through the time-consuming process of subcontractor evaluation and selection before submitting his CD final report.

Second, definition of what is wanted from the subcontractor will change continually as the system requirements evolve during Contract Definition. Thus, contractual negotiation, change, and renegotiation entanglements can be averted by not having an actual contract with several subcontractors.

In the situation where a single subcontractor is working with more than one prime, the subcontractor's concern is with the costliness of the effort. One subcontractor in an aircraft program noted that on a recent Contract Definition he submitted three bids for each of three subsystems to three prime contractors. He was required to prepare six documents for each subsystem, or 18 documents per bid, for a total of 54 documents. In this proposal effort, the subcontractor expended several thousand engineering hours, all without reimbursement.

CD experiences to date indicate that for subcontractors to be responsive to the prime, they must operate under the same "groundrules" as the prime contractors. The subcontractor, like the prime, must perform trade-off analysis to select the approach that provides optimum technical, total cost, and schedule balance. He, too, must develop firm equipment specifications that can be bid on the basis of a fixed price or incentive contract, and he must provide the same kind of planning that the prime contractor is required to provide the government. He must, in essence, act as an extension of the prime contractor in CD analysis planning.

This new CD prime contractor/subcontractor relationship has increased the need for the mutual protection of each party's position. Both prime contractors and subcontractors expressed concern over the security of their designs, plans, and cost estimates. Because Contract Definition has presented a new type of competitive situation, it is important that both parties protect each other's interest by not disclosing competitive approaches. Otherwise, the value of competitive Contract Definition will be lost.

In summary, the new relationship between prime contractors and subcontractors poses difficult management problems for both parties. The success of Contract Definition rests heavily on reaching workable solutions to these problems.

I. The Potential Benefits of Technical Transfusion Depend on the Government's Ability To Gain Unlimited Rights-In-Data for Designs Proposed During Contract Definition.

A distinct advantage to the government of competitive Contract Definitions is the opportunity to select from the alternative contractor approaches. The government can thereby improve the end product of CD by incorporating, through negotiation, desirable features from other CD studies into the successful contractor's project. This procedure is referred to as "technical transfusion." Although technical transfusion has not yet been utilized extensively, it promises to be one of the most beneficial aspects of Contract Definition from the government's standpoint and one of genuine concern from the contractor's viewpoint.

The benefits to the government of technical transfusion depend on the government's ability to secure unlimited rights-in-data for the designs proposed by the CD competitors. This problem pertains not only to the release of rights from the subcontractors and component manufacturers to the prime contractors, but also from the prime contractors to the government. The release of these rights allows the government and the prime contractors to include key items that will result in an optimal system without the cost and time delay of redevelopment.

To gain these unlimited rights, the government is asking the contractors, in the RFQ, to quote a price for releasing them. "Quoting a price" for this release is being handled in a variety of ways. For example, one prime contractor discovered that many of his CD subcontractors who were working with him on an unfunded basis would not make these rights available at any price. Other prime contractors found that in complicated technical hardware areas, their subcontractors would only agree to release data if they were given a sole-source position during CD and development. Another prime contractor was told by a subcontractor who was not sole source during CD that the price for his release

of rights-in-data was a guarantee for the development work. Other subcontractors have taken certain exceptions in releasing any rights-in-data or have simply quoted high surcharges for the release.

A staff member of one prime contractor's CD team indicated that there are a number of alternative strategies that his firm is considering with regard to these rights. His comment on technical transfusion and rights-in-data was, "Before the government dips into my technology and beefs up my competition, it's going to pay the price." As a minimum, he suggested that if the government wants unlimited rights, it should pay for his company's investment in the particular item.

J. A Major Difficulty with Contract Definition Has Been the Excessive Delays in Initiating Development.

On some earlier projects, several problems caused Contract Definition to be extended. These extensions resulted in delays in the start of development, creating schedule problems. Also, some hardships were experienced by the contractors who felt it necessary to maintain their project terms throughout this period.

To identify the causes of these delays, DoD undertook an analysis of the first six projects to undergo CD. (Of these six, only one had begun CD under the guidance of the DoD Directive.) Three of the projects remained in Contract Definition's Phase C for nearly one year; one project consumed from twenty to forty weeks of elapsed time; and two projects took from ten to twenty weeks for these activities.

In two of the six causes, the cause of delay was primarily the fact that the prerequisites had not been met or there was insufficient evidence of the fulfillment of the prerequisites. In three other projects, the specifications prepared by the contractors were not written with minimum acceptable performance requirements. Firm specification requirements had to be prepared during Phase C and resubmitted so that effective contract documents could be written. Other delays were caused by the need for contractor clarification of ambiguous or vague portions of the CD final reports. In some cases, selection of the development contractor was delayed by the additional time it took to evaluate contractor submissions that were difficult to compare.

In several of the projects that experienced the longest delays between the submission of CD final reports and development proposals and the award of the full-scale development contract, slowness of decision within OSD was a major factor in the delay. On one project, OSD had not resolved the mission requirement,

and on another, OSD lacked sufficient information from the service sponsoring the project. These delays can be attributed, in part, to unfamiliarity with the CD process and to the lack of understanding between OSD and the military departments on the groundrules for decision-making and the information required for decision-making. In future projects that undergo Contract Definition, there must be a clear understanding as to who is to make decisions, when decisions are to be made, and the information that is essential for making decisions.

Finally, administrative delays were experienced by the military services, who were working under new conditions for contractor selection, approval of selection, negotiation, and contract execution. In a recent Navy program, administrative delays arose because neither the winning contractor nor the Navy contracts personnel was adequately acquainted with CD activities and had to review the results of past efforts before formalizing a contract. To avoid this situation, it is vital that contracting officers and contract negotiators participate in CD from the project's outset. By so doing, these personnel can expedite the development contracting activities.

Because of these extended periods, some contractors experienced hardships in trying to maintain their CD project teams. One contractor, who was not funded during Phase C, spent nearly \$400,000 of his firm's funds to maintain his key personnel. Because of these expenses, he was forced to reassign some of his personnel to other projects. When he was finally declared the winner and the development effort began, it was almost two months before his project team could be reassembled and could regain the lost momentum. Regardless of whether the contractor is funded or not, as Phase C is extended, he loses the momentum he worked so hard to develop. All contractors feel that the project suffers from this delay.

The results of the analysis of the delays indicated that in some cases, the cause could be rectified by improved government Concept Formulation analysis and planning. Other problems could have been averted through improved guidance to the contractors, both prior and during Contract Definition. Also, time can be saved if the government contracting people become involved early in the project's life, so that a contract can be speedily designed and negotiated.

DoD has now taken some steps to improve the transition from Contract Definition to development. In the future, DoD will designate the source selection authority at the outset in an effort to expedite the decision process. Also, an 18-week goal has been set to complete Phase C. If this goal is to be met, however, all major activities must be thoroughly planned, including those which must be in parallel rather than in series to achieve the schedule objective. In

addition, the activities prior to Phase C must have produced the essential information needed for decisions.

K. The Contractors' Marketing Costs Have Increased Substantially as a Result of Contract Definition.

Contract Definition usually requires that a contractor win two competitions before being awarded a development contract. The contractors' response to this requirement has been to increase their marketing and research expenditures in order to achieve the level of customer confidence required to win.

One contractor undertook a company-funded test program during the Concept Formulation period to demonstrate the feasibility of an area of concern. Some contractors made investments in exploratory development and feasibility studies and provided the data to the military department. Other contractors have gone into design and sometimes even development prior to entering the Contract Definition competition. All of these contractors felt that the investment was necessary to improve their chances of winning in light of competitive activities.

One company, which eventually won a development contract, made a conservative estimate that total marketing costs of all prime and subcontractors competing on the project amounted to one-fourth of the cost of development. On this project, the government provided no funds until Contract Definition. On other projects, the government supplied some funds to contractors during Concept Formulation for exploratory development work, feasibility studies of critical areas, cost/effectiveness studies, and parametric studies to help define the system.

Most contractors have elected to spend more than is funded by the government during CD. The contractors typically attempt to discover the amount programmed for CD and to bid accordingly, regardless of what they expect their actual costs to be. One contractor on an Army project, however, decided not to follow this route. His bid for CD was what he thought his costs actually would be to accomplish the job. The bid was for more funds than the Army had programmed, but the Army selected this contractor to compete in CD and got ready approval from OSD for the additional funds. Both contractors selected for Contract Definition were awarded fixed price contracts based on their bid costs. The other company, which had followed the policy of bidding according to the funds available, was awarded a contract which was 40 percent lower in price.

It is evident that to compete in the environment of CD, contractors must:

- price CD efforts realistically;
- perform only that work which is appropriate during CD, that is, they should not undertake development effort; and
- submit proposals on more funded studies to be undertaken in Concept Formulation, rather than expending only company funds.

The military departments and OSD must:

- set aside sufficient funds for contractors to conduct the comprehensive CD work that is desired, considering as well the possibility of funding CD subcontractors; and
- sponsor and budget funds for Advanced Research and Explanatory Development projects during the Concept Formulation period.